U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: **INFORMATION**: Review and Concurrence, Equivalent Level of Safety Finding for Cessna New Model 680; Use of 1-g Stall Speeds FAA Project No. TC2548WI-T

Date: April 5, 2004

Reg Ref: 14 CFR Part 1, § 1.2 (Abbreviations and symbols); All 14 CFR part 25 sections, except structural, dealing with stall speeds and related factors

From: Manager, Airplane and Flight Crew Interface Branch, ANM-111

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To: Manager, Wichita Aircraft Certification Office, ACE-115W

ELOS Memo #: TC2548WI-T-F-1

Background

An equivalent safety finding for the use of 1-g stall speeds, instead of the minimum speeds obtained in the stalling maneuver, as the basis for showing compliance with certain 14 CFR part 25 performance, was established for several past type certification projects. Pilot objectivity on stall identification has become a key factor in decisions on flying technique, especially where deterrent buffet or excessively low load factors are developed during stalls to $V_{S\ MIN}$. To avoid these problems, and to become consistent with recent certification practice, the application of 1-g stall speed criteria is being expanded to include most areas of the transport-related regulations that use stall speed as a factor.

The 1-g stall requirements were derived to provide a more realistic and consistent basis for the definition of stall speed as the minimum speed at which wing lift alone can support the weight of the airplane in level flight. Service history has not indicated a safety-related deficiency in existing operating speeds that typically have their minimum allowable values defined as a multiple of the $V_{S\ MIN}$ stall speed. Consequently, the 1-g stall Issue Papers have applied reduced operating speed factors for determining the minimum operating speeds in order to compensate for the 1-g stall speeds being higher than $V_{S\ MIN}$ speeds. The net result was little or no change in operating speeds for airplanes with aerodynamic stall thus leading to a finding of equivalent safety.

Applicable regulation(s)

14 CFR part 1, § 1.2 (Abbreviations and symbols); All 14 CFR part 25 sections, except structural, dealing with stall speeds and related factors

Regulation requiring an ELOS

14 CFR Part 1, § 1.2 (Abbreviations and symbols); All 14 CFR part 25 sections, except structural, dealing with stall speeds and related factors

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

The following constitutes the FAA Equivalent Safety Finding for the Cessna Aircraft Company Model 680 Sovereign:

14 CFR Reference	Equivalent Interpretations for Model 680 Sovereign
Part 1 (Definitions and abbreviations) (Section Number)	
1.1	Add the following new definitions: "*Final takeoff speed* means the speed of the airplane that exists at the end of the takeoff path in the en route configuration with one engine inoperative." "*Reference landing speed* means the speed of the airplane, in a specified landing configuration, at the point where it descends through the 50 foot height in the determination of the landing distance."
1.2	Add the following new abbreviations: "V_{FTO} means final takeoff speed." "V_{REF} means reference landing speed." "V_{SR} means reference stall speed." "V_{SR0} means reference stall speed in the landing configuration." "V_{SR1} means reference stall speed in a specific configuration." "V_{SW} means speed at which onset of natural or artificial stall warning occurs."

Part 25 (Airworthiness Standards: Transport Category Airplanes) (Section Number)

25.103(a) Change to read: "The reference stall speed, V_{SR}, is a calibrated airspeed defined by the applicant. V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as:

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{zw}}}$$

where —

$V_{CL_{MAX}}$ = Calibrated airspeed obtained when the load factor-corrected lift coefficient ($\frac{n_{zw}W}{qS}$) is first a maximum during the maneuver prescribed in paragraph (c) of this section. In addition, when the maneuver is limited by a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher), $V_{CL_{MAX}}$ may not be less than the speed existing at the instant the device operates;

n_{ZW} = Load factor normal to the flight path at $V_{CL_{MAX}}$;

W = Airplane gross weight;

S = Aerodynamic reference wing area; and

q = Dynamic pressure."

NOTE: Unless AOA protection system (stall warning and stall identification) production tolerances are acceptably small, so as to produce insignificant changes in performance determinations, the flight test settings for stall warning and stall identification should be set at the low AOA tolerance limit. High AOA tolerance limits should be used for characteristics evaluations.

25.103(a)(1) Remove this paragraph.

25.103(a)(2) Remove this paragraph.

25.103(a)(3) Remove this paragraph.

25.103(a)(4) Remove this paragraph.

25.103(b) Change to read: "$V_{CL_{MAX}}$ is determined with:"

25.103(b)(1) Change to read: "Engines idling, or, if that resultant thrust causes an appreciable decrease in stall speed, not more than zero thrust at the stall speed;"

25.103(b)(2)	Change to read: "Propeller pitch controls (if applicable) in the takeoff position;"
25.103(b)(3)	Insert a new paragraph that reads: "The airplane in other respects (such as flaps and landing gear) in the condition existing in the test or performance standard in which V_{SR} is being used;"
25.103(b)(4)	Insert a new paragraph that reads: "The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;"
25.103(b)(5)	Insert a new paragraph that reads: "The center of gravity position that results in the highest value of reference stall speed; and"
25.103(b)(6)	Insert a new paragraph that reads: "The airplane trimmed for straight flight at a speed selected by the applicant, but not less than 1.13 V_{SR} and not greater than 1.3 V_{SR}."
25.103(c)	Insert a new paragraph that reads: "Starting from the stabilized trim condition, apply the longitudinal control to decelerate the airplane so that the speed reduction does not exceed one knot per second."
25.103(d)	Insert a new paragraph that reads: "In addition to the requirements of paragraph (a) of this section, when a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher) is installed, the reference stall speed, V_{SR}, may not be less than 2 knots or 2 percent, whichever is greater, above the speed at which the device operates."
25.107(b)(1)	Change "1.2 V_S" to "1.13 V_{SR}."
25.107(b)(2)	Change "1.15 V_S" to "1.08 V_{SR}."
25.107(c)(3)	Insert a new paragraph that reads: "A speed that provides the maneuvering capability specified in § 25.143(g)."
25.107(g)	Insert a new paragraph that reads: "V_{FTO}, in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by § 25.121(c), but may not be less than— (1) 1.18 V_{SR}; and (2) A speed that provides the maneuvering capability specified in § 25.143(g)."
25.111(a)	Replace "a speed is reached at which compliance with § 25.121(c) is shown" with "V_{FTO} is reached."

25.119(b)	Change to read: "A climb speed of not more than V_{REF}."
25.121(c)	Replace "at not less than 1.25 V_S and with—" with "at V_{FTO} and with —"
25.121(d)	Change to read: "In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110 percent of the V_{SR} for the related all-engines-operating landing configuration, the steady gradient of climb may not be less than 2.1 percent for two-engine airplanes, 2.4 percent for three-engine airplanes, and 2.7 percent for four engine airplanes, with—"
25.121(d)(3)	Replace ". . .but not exceeding 1.5V_S" with ". . .but not more than 1.4 V_{SR}; and"
25.121(d)(4)	Add new paragraph as follows: "Landing gear retracted."
25.125(a)(2)	Change to read: "A stabilized approach, with a calibrated airspeed of not less than V_{REF}, must be maintained down to the 50 foot height. V_{REF} may not be less than— (i) 1.23 V_{SR0}; and (ii) V_{MCL} established under § 25.149(f); and (iii) A speed that provides the maneuvering capability specified in § 25.143(g)."
25.143(g)	Insert a new paragraph that reads: "The maneuvering capabilities in a constant speed coordinated turn at forward center of gravity, as specified in the following table, must be free of stall warning or other characteristics that might interfere with normal maneuvering:

CONFIG-URATION	SPEED	MANEUVERING BANK ANGLE IN A COORDINATED TURN	THRUST/POWER SETTING
TAKEOFF	V_2	30°	ASYMMETRIC WAT-LIMITED.(1)
TAKEOFF	V_2 + XX (2)	40°	ALL-ENGINES-OPERATING CLIMB.(3)
ENROUTE	V_{FTO}	40°	ASYMMETRIC WAT-LIMITED.(1)
LANDING	V_{REF}	40°	SYMMETRIC FOR -3° FLIGHT PATH ANGLE

(1) A combination of weight, altitude and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in § 25.121 for the flight condition.

(2) Airspeed approved for all-engines-operating initial climb.

(3) That thrust or power setting which, in the event of failure of the critical engine and without any crew action to adjust the thrust or power of the remaining engines, would result in the thrust or power specified for the takeoff condition at V_2, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures."

25.145(a) Change to read: "It must be possible, at any point between the trim speed prescribed in § 25.103(b)(6) and stall identification (as defined in §25.201(d)), to pitch the nose downward so that the acceleration to this selected trim speed is prompt with—"

25.145(a)(1) Change to read: "The airplane trimmed at the trim speed prescribed in § 25.103(b)(6);"

25.145(b)(1) Change to read: "With power off, flaps retracted, and the airplane trimmed at 1.3 V_{SR1}, extend the flaps as rapidly as possible while maintaining the airspeed at approximately 30 percent above the reference stall speed existing at each instant throughout the maneuver."

25.145(b)(4) Change "1.4 V_{S1}" to "1.3 V_{SR1}."

25.145(b)(6) Change to read: "With power off, flaps extended, and the airplane trimmed at 1.3 V_{SR1}, obtain and maintain airspeeds between V_{SW} and either 1.6 V_{SR1} or V_{FE}, whichever is lower."

25.145(c)	Change to read: "It must be possible, without exceptional piloting skill, to prevent loss of altitude when complete retraction of the high lift devices from any position is begun during steady, straight, level flight at 1.08 V_{SR1} for propeller powered airplanes, or 1.13 V_{SR1} for turbojet powered airplanes, with —"
25.147(a), (a)(2), (c), and (d)	Change "1.4 V_{S1}" to "1.3 V_{SR1}."
25.149(c)	Change "1.2 V_S" to "1.13 V_{SR}."
25.161(b), (c)(1), (c)(2), (c)(3), and (d)	Change "1.4 V_{S1}" to "1.3 V_{SR1}."
25.161(e)(3)	Change "0.013 V_{S0}^2" to "0.013 V_{SR0}^2."
25.175(a)(2), (b)(1), (b)(2), (b)(3), and (c)(4)	Change "1.4 V_{S1}" to "1.3 V_{SR1}."
25.175(b)(2)(ii)	Change "V_{MO} + 1.4 V_{S1}/2" to "(V_{MO} + 1.3 V_{SR1})/2."
25.175(c)	Change ". . .at speeds between 1.1 V_{S1} and 1.8 V_{S1}" to ". . .at speeds between V_{SW} and 1.7 V_{SR1}."
25.175(d)	Change ". . .at speeds between 1.1 V_{S0} and 1.3 V_{S0}" to ". . .at speeds between V_{SW} and 1.7 V_{SR0}."
25.175(d)(5)	Change "1.4 V_{S0}" to "1.3 V_{SR0}."
25.177(c)	Change "1.2 V_{S1}" to "1.13 V_{SR1}."
25.181(a) and (b)	Change "1.2 V_S" to "1.13 V_{SR}."
25.201(a)(2)	Change to read: "The power necessary to maintain level flight at 1.5 V_{SR1} (where V_{SR1} corresponds to the reference stall speed at maximum landing weight with flaps in the approach position and the landing gear retracted)."
25.201(b)(4)	Change to read: "The airplane trimmed for straight flight at the speed prescribed in § 25.103(b)(6)."
25.207(b)	Change to read: "The warning must be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in

	paragraph (a) of this section at the speed prescribed in paragraphs (c) and (d) of this section."
25.207(c)	Change to read: "When the speed is reduced at rates not exceeding one knot per second, stall warning must begin, in each normal configuration, at a speed, V_{SW}, exceeding the speed at which the stall is identified in accordance with § 25.201(d) by not less than five knots or five percent CAS, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which stall warning began."
25.207(d)	Insert a new paragraph that reads: "In addition to the requirement of paragraph (c) of this section, when the speed is reduced at rates not exceeding one knot per second, in straight flight with engines idling and at the center of gravity position specified in § 25.103(b)(5), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than three knots or three percent CAS, whichever is greater."
25.207(e)	Insert a new paragraph that reads: "The stall warning margin must be sufficient to allow the pilot to prevent stalling (as defined in § 25.201(d)) when recovery is initiated not less than one second after the onset of stall warning in slow-down turns with at least 1.5g load factor normal to the flight path and airspeed deceleration rates of at least 2 knots per second, with the flaps and landing gear in any normal position, with the airplane trimmed for straight flight at a speed of 1.3 V_{SR}, and with the power or thrust necessary to maintain level flight at 1.3 V_{SR}."
25.207(f)	Insert a new paragraph that reads: "Stall warning must also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures (including all configurations covered by Airplane Flight Manual procedures)."
25.231(a)(2)	Change to read: "If a tail-wheel landing gear is used, it must be possible, during the takeoff ground run on concrete, to maintain any attitude up to thrust line level, at 75 percent of V_{SR1}."
25.233(a)	Change "0.2 V_{S0}" to "0.2 V_{SR0}."
25.237(a), (b)(1), and (b)(2)	Change "0.2 V_{S0}" to "0.2 V_{SR0}."
SUBPART D	
25.735(f)(2)	Change to read: "Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel-brake assembly may

be derived from the following formula, which must be modified in cases of designed unequal braking distributions.

$$KE = \frac{0.0443WV^2}{N}$$

where —

KE = Kinetic energy per wheel (ft.-lb.);

W = Design landing weight (lb.);

V = $V_{REF}/1.3$

V_{REF} = Airplane steady landing approach speed, in knots, at the maximum design landing weight and in the landing configuration at sea level; and

N = Number of main wheels with brakes."

25.735(g) Change to read: "In the landing case, the minimum speed rating of each main wheel-brake assembly (that is, the initial speed used in the dynamometer tests) may not be more than the V used in the determination of kinetic energy in accordance with paragraph (f) of this section, assuming that the test procedures for wheel-brake assemblies involve a specified rate of deceleration, and, therefore, for the same amount of kinetic energy, the rate of energy absorption (the power absorbing ability of the brake) varies inversely with the initial speed."

25.773(b)(1)(i) Change "1.6 V_{S1}" to "1.5 V_{SR1}."

SUBPART E

25.1001(c)(1) and (c)(3) Change "1.4 V_{S_1}" to "1.3 V_{SR1}."

SUBPART F

25.1323(c)(1) Change "1.3 V_{S1}" to "1.23 V_{SR1}."

25.1323(c)(2) Change "1.3V_{S0}" to "1.23V_{SR0}."

25.1325(e) Change ". . .in the speed range between 1.3 V_{S0} with flaps extended and 1.8 V_{S1} with flaps retracted" to "...in the speed range between 1.23 V_{SR0} with flaps extended and 1.7 V_{SR1} with flaps retracted."

25.1587(b)(2) Change "V_S" to "V_{SR}."

Explanation of how design features or alternative standards provide an equivalent level of safety intended by the regulation:

The alternative standards outlined above were subsequently adopted in the 14 CFR part 25 requirements at Amendment 25-108, Eff. 12/26/2002.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned Equivalent Level of Safety Finding in Issue Paper F-1. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Transport Directorate has assigned a unique ELOS Memorandum number (see front page) to facililitate archiving and retrieval of this ELOS. This ELOS Memorandum Number should be listed in the Type Certificate Data Sheet under the Certification Basis section. [e.g. Equivalent Safety Findings have been made for the following regulations: § 25.103 & related paragraphs, 1-G Stall Speeds (documented in TAD ELOS Memo TC2548WI-T-F-1)]

/s/

Signature: Stephen P. Boyd
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Date: April 5, 2003

ELOS Originated by Wichita ACO	Program Manager, Tina Miller	Routing Symbol ACE-117W

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